



National Position, Navigation and Timing Architecture Overview



Overview



- PNT Architecture Background
- Architecture Development
- Initial Findings



PNT Architecture Background



- Study requested by
 - National PNT Executive Committee
 - Under Secretary of Defense for Networks, Information and Integration
 - Department of Transportation
- Products
 - 20 year strategic outlook to guide near and mid-term decisions on PNT capabilities



National PNT Architecture - Justification

- PNT Strategic Landscape is Changing
 - Missions & Applications
 - Greater need for PNT Services
 - Technology
 - Rapid Change affecting PNT Services
 - PNT Services
 - More providers - increased competition and/or integration
 - Will affect Military, Civil and Commercial communities
- Strategic Vision Needed
 - Sustain and advance global PNT capabilities
 - Meet long term user needs affordably and effectively



Purpose of NSSO Architectures



- Enterprise Level Guidance

- High Level Capabilities
- Fundamental Processes
- Organizations
- Infrastructure



- Similar to City Planning

- Considerations for how people, buildings, transportation, utilities work together
- Effect of External Factors (e.g., weather, state jurisdiction, etc.)
- May conduct detailed design of some elements, primarily to gain understanding of higher level issues

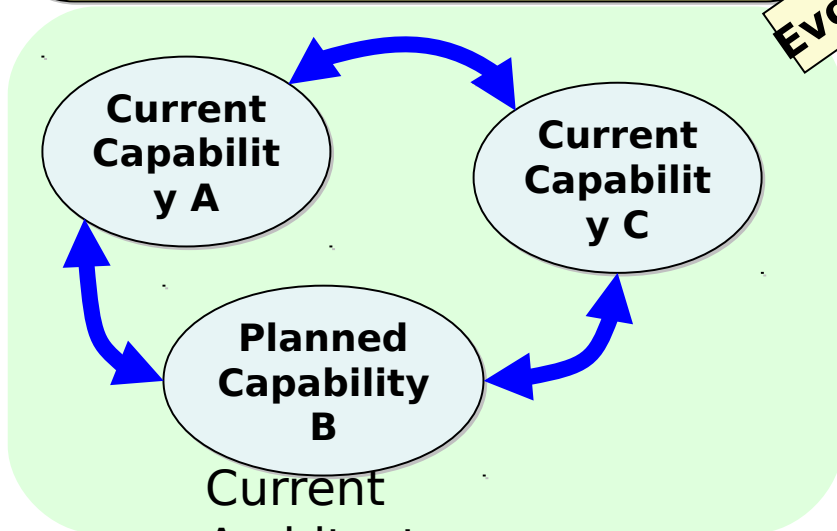




NSSO Architecture Emphasis

Enterprise Assessment of Governing Principals

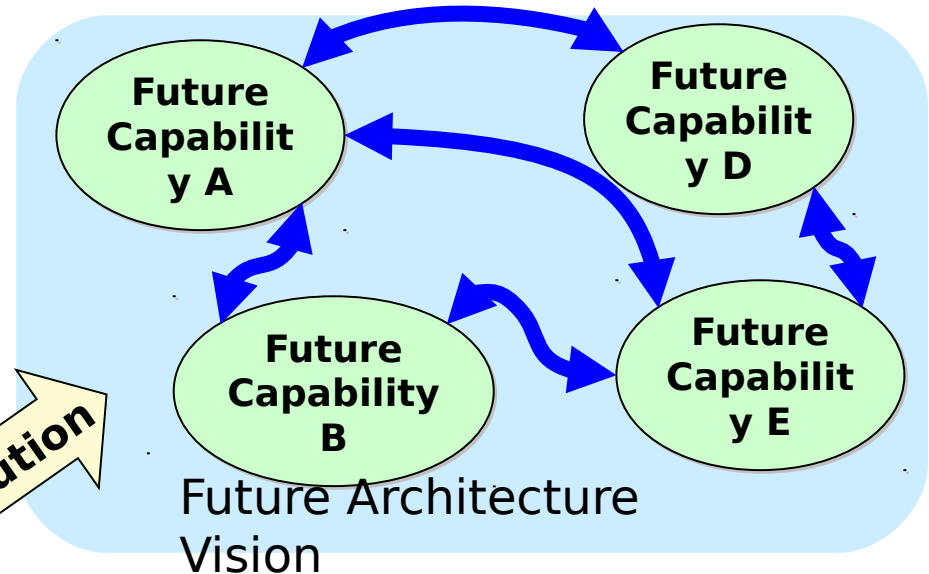
- National & International Policy agencies, governments and users
- Capabilities provided by systems of systems
- Infrastructure that provides the foundation for future capabilities



Current

Architecture

Evolution



Future Architecture
Vision

Recommendations

- Guidance on Policy, Capabilities and Infrastructure
- Helps provide context for near and mid term decisions
- Leads to long term benefits

Sep 2, 2016

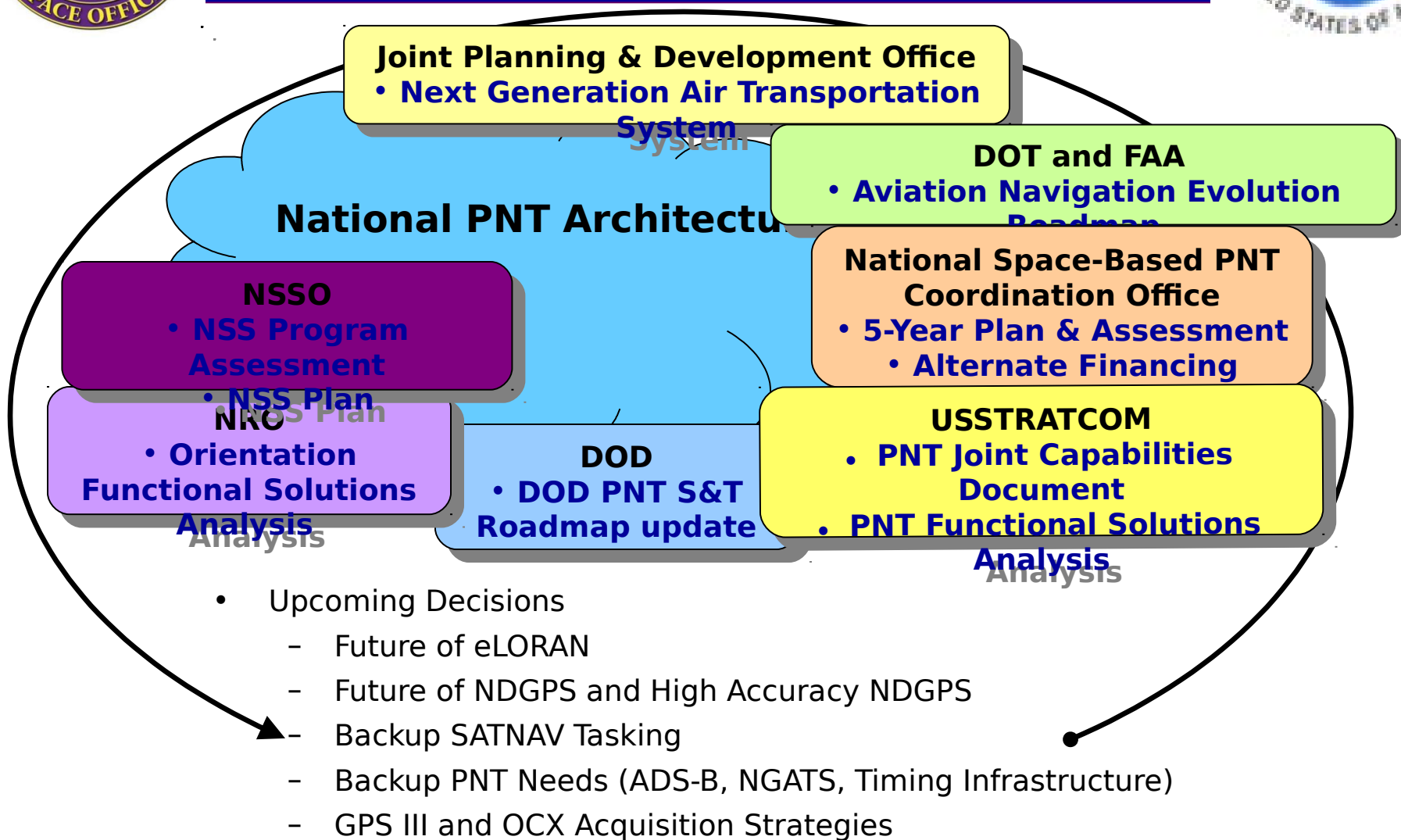


Overview of Civil PNT Challenges

- Diverse Set of Applications with Different Performance Requirements
- No Overarching Strategy Documents to Define Civil GPS/PNT Requirements – Identified in Civil PNT Analysis of Alternatives Study
- Promulgation of GPS Augmentation Systems
- What is the “Right” Mix of Terrestrial, Space, Based of Autonomous NavAids to Meet Performance Requirements?
- What is the “Right” Mix of Government-Provided GPS Augmentation Systems? Commercial Systems?
- Within Federal Government, Which Agency Funds a Program with Overlapping Requirements?

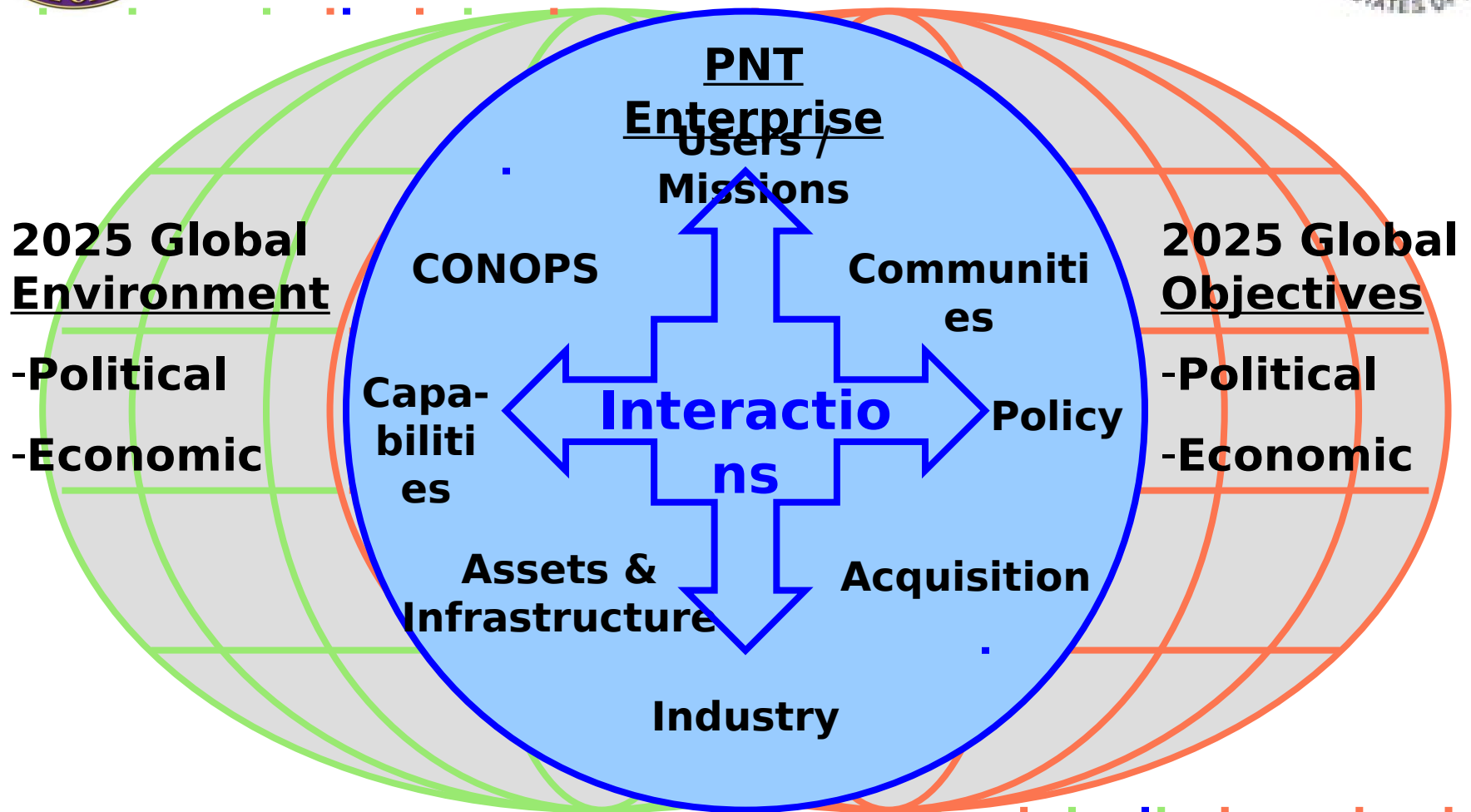


Related Efforts & Upcoming Decisions





National PNT Architecture Perspective

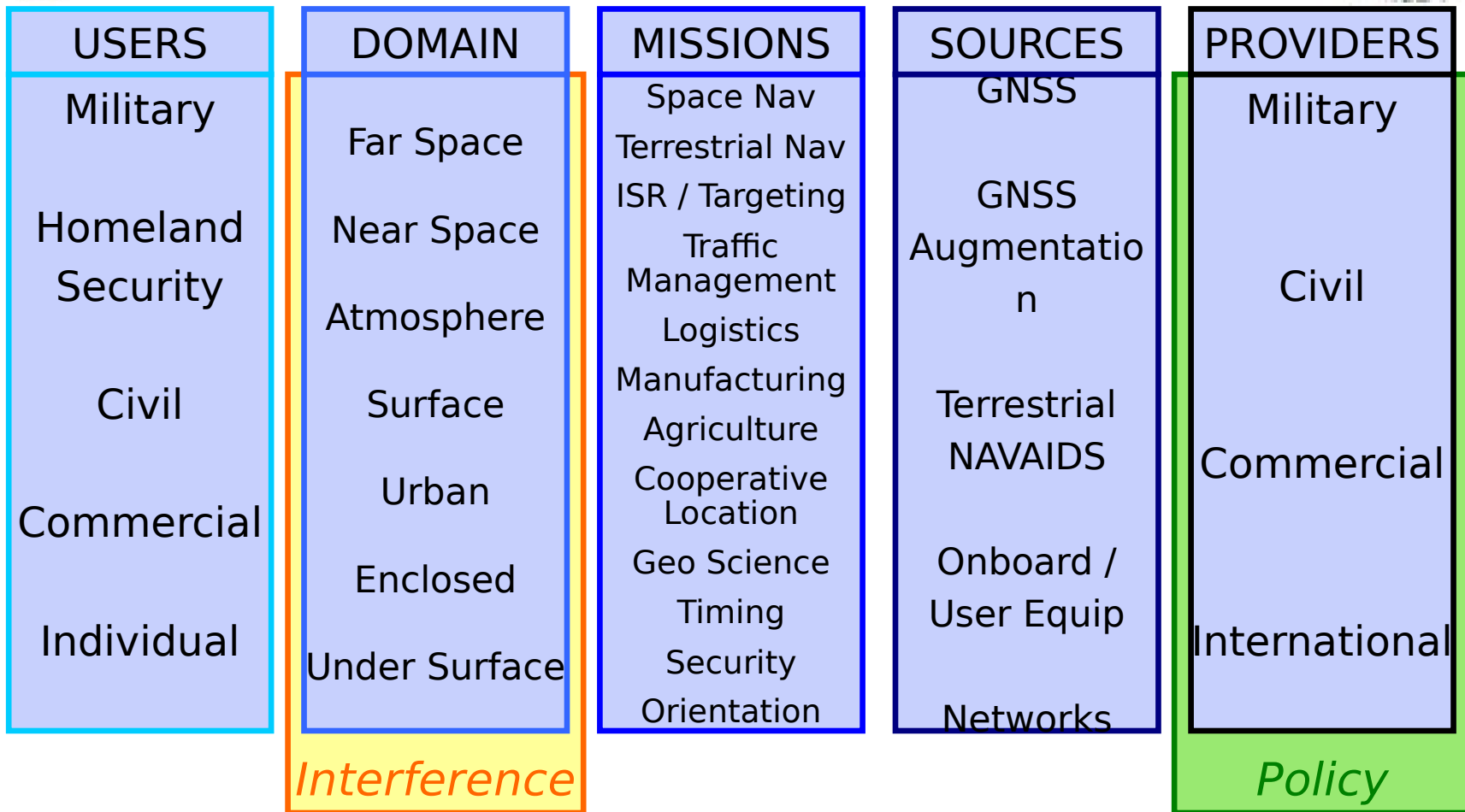


Enterprise Level Assessment to Ensure National PNT Preeminence

Cross-Community Forum to Achieve Common



National PNT Architecture Scope



Broad Scope Requires Innovative Approaches and Focused Analysis Efforts



PNT Architecture Stakeholders



- National Security Space Office
- US Naval Observatory
- US Air Force
- US Dept of Commerce
- Joint Planning Development Office
- NPCO
- NASA
- US Dept of Transportation / RITA
- US Dept of Transportation / FAA
- US Dept of State
- DoD (S&T)
- DoD (Networks, Information & Integration)
- Department of Interior
- Dept of Homeland Security
- US Coast Guard
- US Navy
- National Security Agency
- US Army
- NGA
- Joint Staff
- US Strategic Command
- US Marine Corp
- GPS Wing (SMC/GP)
- National Institute for Standards and Technology
- Policy Board on Federal Aviation
- Department of Agriculture



Architecture Development Overview



- Data Gathering Phase
 - 2006 PNT Architecture - "As-Is"
 - Future Environment, Missions, Technology
 - 2025 PNT Architecture - Evolved Baseline (EBL)
- Concept Development Phase
 - Assessment of EBL Shortfalls
 - Define Concepts to mitigate EBL shortfalls
 - Create Architectures based on groups of concepts
- Analysis Phase
 - Analyze Representative Architectures for Cost & Performance
- Assessment Phase
 - Findings and Recommendations



Current Status



- First Cycle Completed in August 2006
 - Team familiarization with issues and process
 - Emphasis on Data Gathering
- Second Cycle to be completed in March 2007
 - Emphasis on Architecture Concepts and Analysis
- Third and final cycle to be completed by Jul 2007
 - Final Report
 - Coordination with Stakeholders

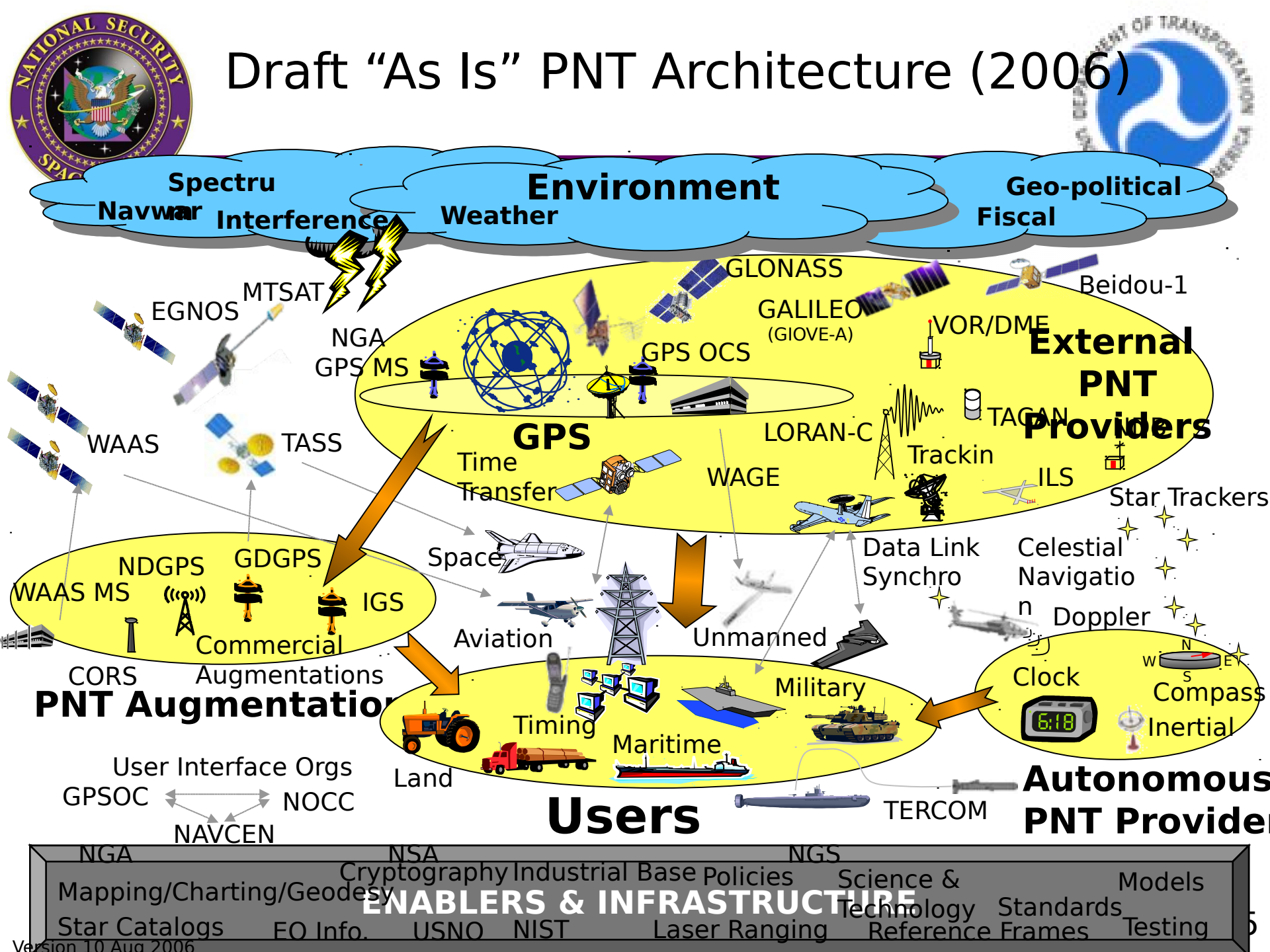


Preliminary Products



- As-Is Architecture (2006)
- Evolved Baseline (EBL) Architecture (2025)
- Architecture Level Trades
- Initial Findings and Concerns

Draft "As Is" PNT Architecture (2006)



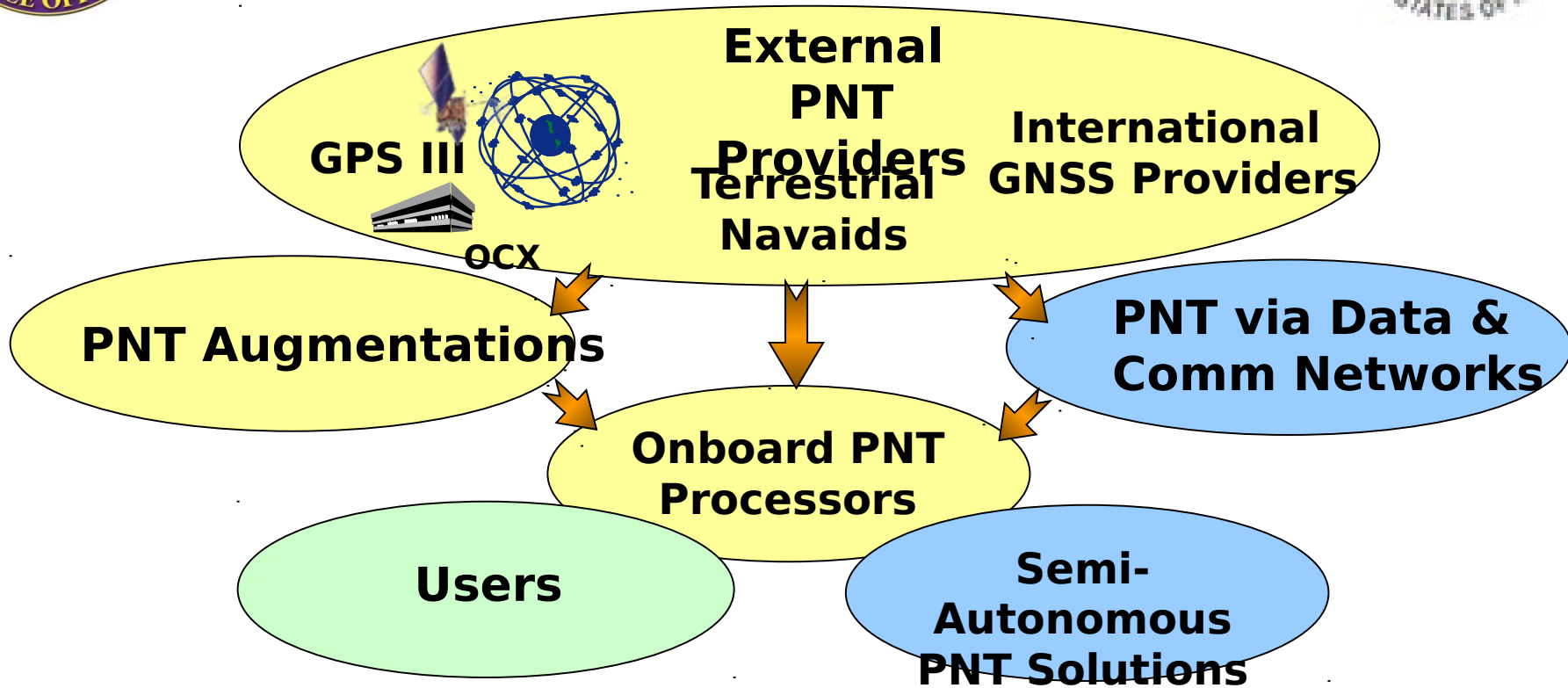


1. **Identify the main components of the system.**





Draft Evolved Baseline (2025)



Greater Demand for PNT services	Demand for Increased Accuracy and Assurance	Increased Integration Across Communities	Increased Integration with Other Applications	New Technologies and Applications	Increased Numbers of PNT Suppliers
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Potential EBL Technologies

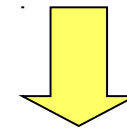
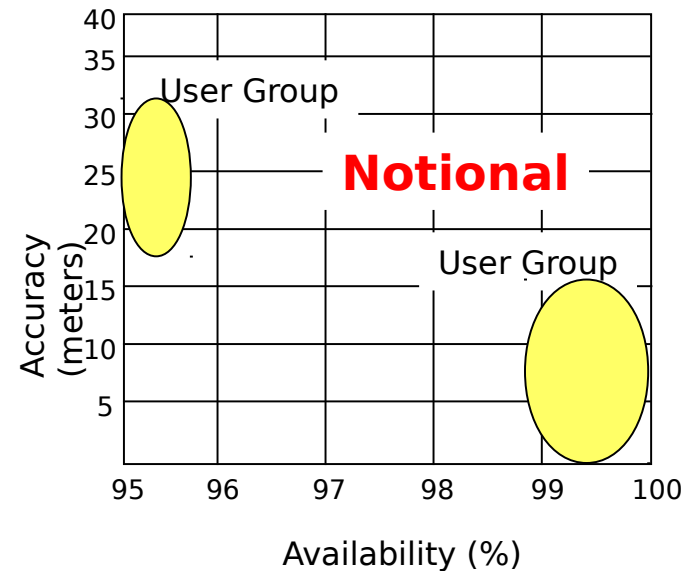
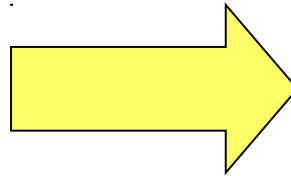


- Enablers
 - Quantum applications (processing; comm)
 - Optics and laser capabilities
 - Distributed & Networked PNT Services
 - New spectra / radiometrics available for PNT services
 - Improved astrometry
 - Precision gravimetrics and bathymetrics
 - Improved topographic mapping
- Applications
 - Blue Force Situational Awareness
 - Urban / Interior Navigation
 - Intelligent Transportation
 - Missing Person Locator
 - Machine Level Location
 - Orientation
 - Data security and verification (including location)
 - GEO and Deep Space Missions



Analysis - Framing the Needs

- Accuracy
- Availability
- Integrity
- Timeliness
- Coverage
- Continuity
- Precision
- Security



What are the appropriate combinations of axes?
What are the priority axes?

Accuracy vs. Availability
Availability vs. Integrity
Timeliness vs. Integrity
Accuracy vs.



Analysis - Performance and Utility

Evolved Baseline Team Concept Teams

- Evolved Baseline
- Representative Architectures

Stakeholder SMEs, tools, and resources are needed to help perform the various analyses

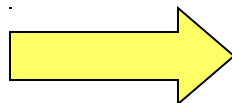
Needs Team

- Attributes and Values
- Scenarios

Future Environment Team

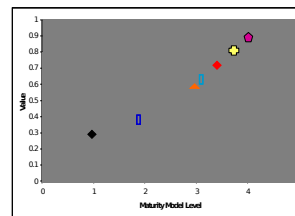
- Trends
- Threats
- Scenarios

Analysis Development



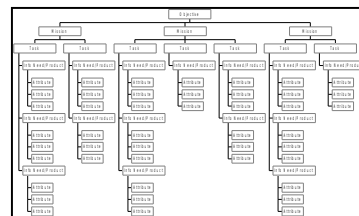
Cost and Risk also need to be analyzed

Performance and Utility Analyses

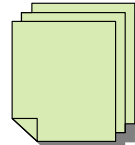


EX PERFORMANCE EVALUATION									
Team Specific Data									
Team	Strategy	Availability	Reliability	Security	Scalability	Flexibility	Interoperability	Resilience	Adaptability
Evolved Baseline	High	High	High	High	High	High	High	High	High
Representative Architectures	High	High	High	High	High	High	High	High	High
Needs Team	High	High	High	High	High	High	High	High	High
Future Environment Team	High	High	High	High	High	High	High	High	High
Stakeholder SMEs	High	High	High	High	High	High	High	High	High

Legend: CAADL Color Mapping
 1 = 0.0 (Highly Effective)
 2 = 0.1 (Highly Effective)
 3 = 0.2 (Highly Effective)
 4 = 0.3 (Highly Effective)
 5 = 0.4 (Highly Effective)
 6 = 0.5 (Highly Effective)
 7 = 0.6 (Highly Effective)
 8 = 0.7 (Highly Effective)
 9 = 0.8 (Highly Effective)
 10 = 0.9 (Highly Effective)



	Arch 1	Arch 2	Arch 3	Arch 4
Environment 1				
Accuracy				
Availability				
Integrity				
Security				
Timeliness				
Coverage				
Continuity				



Studies



Initial Findings (1)

- Architecture will need to balance Military, Civilian and Commercial needs
 - All communities desire increased accuracy and assurance
 - Mission specific needs will be very diverse
- Commercial PNT investments and services will increase significantly over the next 20 years
 - Military users will become more dependent on commercial products and services
 - Increased competition among international GNSS services



Initial Findings (2)



- PNT services will become more tightly integrated with other information enabled applications
 - Manufacturing, agriculture, ground transportation, communications, surveillance, tracking and targeting
- PNT services will be challenged by
 - Signal Interference and Spectrum Management
 - More sophisticated threats against Signals, Networks and Assets
- Demand for assured PNT in RF impeded environments (interference and obscuration) will increase



Initial Findings (3)

- Architecture will need to determine appropriate methods of GNSS signal augmentation
 - Space-based vs. Land-based
- Significant potential exists for future PNT services to be provided by networked or autonomous systems
 - Current mobile phone networks can provide rudimentary position data
 - Potential development of micro inertial navigation systems and chip scale clocks



Planned Industry Days



- Outreach to Industry for Input on Future of PNT
 - Applications and Technology
- October 11-12
 - NSSO Fairfax, VA
- October 17-18
 - Aerospace Corp. El Segundo, CA



PNT Architecture Contact



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